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UDC 621·822·5 (First Reprint NOVEMBER 1991) IS : 3980 - 1982

(Reaffirmed 2005)

Indian Standard

SPECIFICATION FOR POROUS METAL POWDER OIL-IMPREGNATED BEARINGS

(First Revision)

Plain Bearings Sectional Committee, EDC 80 [Ref : Doc : EDC 80 (3532)]

1. Scope — Specifies requirements of materials, dimensions, tolerances, inspection and testing procedures for porous metal powder oil-impregnated bearings.

2. Types

Grade 1 — Copper Base :
  Class A : Copper - tin
  Class B : Copper - iron - tin

Grade 2 — Iron Base :
  Class A : Pure iron
  Class B : Iron - copper

3. Material — The chemical composition of the material to be used shall be as given in Table 1

TABLE 1 CHEMICAL COMPOSITION OF THE MATERIAL FOR POROUS METAL POWDER OIL-IMPREGNATED BEARING

Grade 1 (Copper Base)					Grade 2 (Iron Base)				
Class A		Class B			Class A		Class B		
Element	Percentage	B_3	B_2 Percentage	B_1	Element	Percentage	B_3	B_2 Percentage	B_1
Iron	1·0, *Max*	48-50	38-40	28-30	Copper	0·5, *Max*	9-11	4-6	1·5-3·5
Tin	8-9·5	4-6	4-6	4-6	Carbon, *Max*	0·25	0·25	0·25	0·25
Carbon, *Max*	2·0	2·0	2·0	2·0	*Total other elements, *Max*	2·0	2·0	2·0	2·0
*Total other elements, *Max*	2·0	2·0	2·0	2·0	Iron	R†	R†	R†	R†
Copper	R†	R†	R†	R†					

***Note** — Total other elements may constitute the following elements in varying proportions depending upon the manufacturer :

For Grade 1 (Copper base) — Lead, zinc, nickel and antimony.

Total other elements by difference 0·55 percent, *Max*.

[*see* IS : 8485-1977 ' Copper powder for powder metallurgical applications '.]

For Grade 2 (Iron base) — Silicon, aluminium, nickle, and tin.

Total other elements by difference 0·55 percent, *Max*

[*see* IS : 8370-1977 'Iron powders for powder metallurgical applications '.]

†Remainder.

Adopted 18 November 1982 | © April 1983, BIS | Gr 5

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

4. Dimensions and Tolerances

4.1 The dimensions of porous metal powder oil-impregnated plain sleeve bearings shall be as given in Table 2.

TABLE 2 DIMENSIONS OF POROUS METAL POWDER OIL-IMPREGNATED PLAIN SLEEVE BEARINGS

All dimensions in millimetres.

Nominal Size (1)	Inside Diameter, *Max* (2)	Outside Diameter, *Max* (3)	Length (4)
3 × 6	3·040	6·060	3-4
4 × 8	4·040	8·060	3-4-6
6 × 10	6·050	10·075	4-6-10
8 × 12	8·050	12·075	6-8-12
10 × 16	10·060	16·075	8-10-16
12 × 18	12·060	18·090	8-12-20
14 × 20	14·060	20·090	10-14-20
15 × 21	15·060	21·090	10-15-25
16 × 22	16·060	22·090	12-16-25
18 × 24	18·075	24·090	12-18-30
20 × 26	20·075	26·090	15-20-25-30
22 × 28	22·075	28·090	15-20-25-30
25 × 32	25·075	32·110	20-25-30-35
28 × 36	28·075	36·110	20-25-30-35
30 × 38	30·090	38·110	20-25-30-40
32 × 40	32·090	40·130	20-25-30-40
38 × 48	38·090	48·130	25-35-45-55
40 × 50	40·110	50·150	30-40-50
45 × 55	45·110	55·150	35-45-55
50 × 60	50·130	60·150	35-45-55

4.1.1 Unless otherwise specified by the purchaser, standard chamfers 0·25 × 45° to 0·6 × 45° in accordance with IS : 3457-1966 'Radii and chamfers for general engineering purposes' shall be provided both on the inside and outside diameter, varying with the diameter of the bearing.

4.2 The tolerances on dimensions of porous metal powder oil-impregnated bearing shall be as given in Tables 3 and 4.

4.2.1 Guidance on the method of measurement of the dimensions is given in Table 5 read with Fig. 1 to 3.

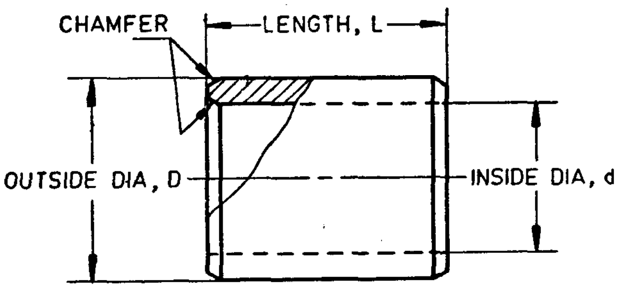

FIG. 1 PLAIN SLEEVE BEARING

TABLE 3 TOLERANCES FOR INSIDE AND OUTSIDE DIAMETERS FOR POROUS METAL POWDER OIL-IMPREGNATED BEARINGS

(*Clause* 4.2)

Nominal Inside or Outside Diameter		**Total Tolerances in Microns**	
Over mm	Up to and Including mm	Grade 1	Grade 2
3	6	15	18
6	10	18	21
10	18	21	25
18	30	25	32
30	40	32	40
40	50	40	52
50	65	52	63
65	80	63	72

Note 1 — Total tolerance on the inside/outside diameters is a minus tolerance only.

Note 2 — Tolerance for housing shall conform to H7 in accordance with IS : 919 (Part I) - 1963 'Recommendation for limits and fits for engineering : Part I General engineering (*first revision*)'.

Note 3 — Tolerance shown in the table apply to Grade 1 bearings with 4 : 1 maximum ratio of length to inside diameter and 24 : 1 maximum ratio of length to wall thickness, and Grade 2 bearings with 3 : 1 to maximum ratio of length to inside diameter and 20 : 1 maximum ratio of length to wall thickness. The bearings having greater ratio than these are not covered by the table.

Note 4 — Other dimensional tolerances for plain sleeve and flanged bearings shall be as per the following tolerance grades in accordance with IS : 919 (Part I) - 1963:

i) *Length* : js13

ii) *Concentricity* : The concentricity tolerance (full indicated movement) of the outside diameter with respect to the inside diameter shall be IT10. The value of the IT10 shall be that which applies to the outside diameter.

iii) *Flange diameter and thickness* : js13

Example :

A porous metal bearing of size 12 × 18 × 20 mm of Grade 1 shall have the following limits of size :

Inside diameter : 12·060 mm, *Max*
12·039 mm, *Min*

Outside diameter : 18·090 mm, *Max*
18·065 mm, *Min*

Length : 20·165 mm, *Max*
19·835 mm, *Min*

Concentricity : 84 microns

TABLE 4 TOLERANCES FOR SELF-ALIGNING BEARINGS

(*Clause* 4.2)

Inside diameter	H 7
Spherical diameter	h 11
Length	js 13

Note — For ease of manufacture a cylindrical surface is permissible on the sphere at the centre of the bearing length.

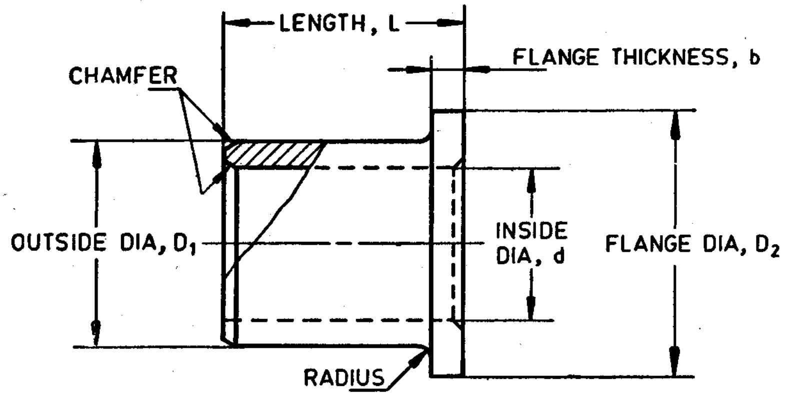

FIG. 2 FLANGED BEARING

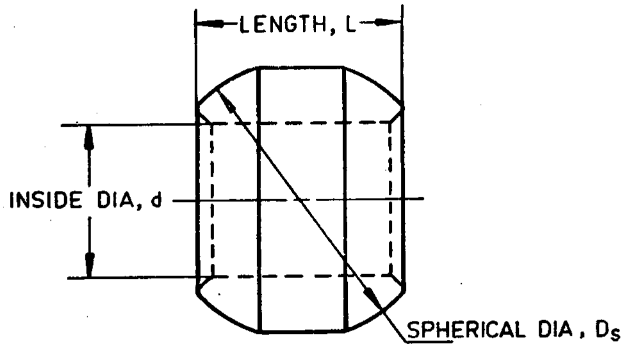

FIG. 3 SELF-ALIGNING BEARING

TABLE 5 DIMENSIONS, MEANS OF MEASUREMENT AND ACCEPTABLE LIMITS

(*Clauses* 4.2.1, 8.2 and Fig. 1, 2 *and* 3)

Type of Bearing	Dimensional Characteristics	Means of Measurement
Plain Sleeve Bearings	*d*	IS : 6137-1980 'Gauging members for plain plug auges GO and NOT GO members (size range 1 to 40 mm) ' IS : 6244-1980 'Gauging members for plain plug gauges GO and NOT GO members (size range above 40 to 120 mm)'
	D	IS : 2967-1983 ' External micrometers (*first revision*) '
	L	IS : 3651-1982 'Vernier calipers (*second revision*)' IS : 2967-1983
	Concentricity	IS : 2092-1983 ' Dial gauges (*first revision*) '
Flanged Bearings	*d*	IS : 6137-1980 IS : 6244-1980
	D_1	IS : 2967-1983
	D_2	IS : 3651-1982 IS : 2967-1983
	L	IS : 3651-1982 IS : 2967-1983
	b	IS : 3651-1982 IS : 2967-1983
	Concentricity	IS : 2092-1983
Self-aligning Bearings,	*d*	IS : 6137-1980 IS : 6244-1980
	D_S	IS : 2967-1983
	L	IS : 3651-1982 IS : 2967-1983

5. Manufacture, Workmanship and Finish — The bearings shall be made by pressing and sintering metal powders so as to produce finished parts. The bearings shall be uniform in composition. When cut out or fractured, the exposed surface shall be of uniform appearance. The parts shall be free from defects affecting their serviceability.

6. Designation — Shall be designated by nomenclature, the nominal size, length, number of this standard, grade, class and density level.

Example :

Porous metal powder bearing having nominal size 12 × 18, length of 40 mm made from Grade 1 Class A material to Low Density Level (5·8 – 6·2 g/cm^3) *L*, shall be designated as :

Porous Metal Powder Bearing 12 × 18 × 40 IS : 3980-1AL

7. Tests

7.1 *Density* — The density of bearings supplied fully impregnated with lubricant when determined in accordance with the method described in IS : 4841 (Part I) - 1968 'Method for determination of density of sintered metallic materials', shall be within the limits prescribed in Table 6.

7.2 *Porosity* — The porosity in terms of interconnected void space when determined in accordance with the method described in IS : 5642-1970 'Method for determination of interlocking porosity of sintered powder metal structural parts and oil-impregnated bearings' shall not be less than the values prescribed in Table 6.

7.3 *Radial Crushing Strength* — The radial crushing strength shall not be less than the value calculated as follows:

$$P = \frac{KWT^2}{D-T}$$

where

P = Radial crushing strength in Newtons,
K = Strength constant in MPa shown in Table 6 for the type specified,
W = Bearing length in mm,
T = Wall thickness in mm, and
D = Outside diameter of bearing in mm.

7.3.1 The radial crushing strength shall be determined by compressing the test specimen between two flat surfaces, the direction of load being normal to the longitudinal axis of the specimen. The point at which the load drops due to the first crack shall be considered the crushing strength. This test shall be applied to plain cylindrical bearings. Flanged bearings shall be tested by cutting off the flange and compressing the two parts separately. Each section shall satisfy the minimum strength requirements as specified in **7.3**.

8. Sampling

8.1 *Lot* — If not specified, a lot shall consist of bearings of the same form and dimensions made from powders of the same composition, formed and sintered under the same conditions and submitted for inspection at one time.

8.2 *Sampling for Dimensional Measurements* — Unless otherwise agreed to between the manufacturer and the purchaser, the single sampling plan with inspection level III given in Table 1 and acceptable quality level 1·5 given in Table 2 of IS : 2500 (Part I) - 1973 'Sampling of tables: Part I Inspection by attributes and by count of defects (*first revision*)' shall be followed, the means of measurement and the acceptable limits are given in Table 5.

8.3 *Sampling for Physical Tests* — Unless otherwise agreed to between the manufacturer and the purchaser, five specimens from each lot of 10 000 pieces or less and atleast 10 specimens from a lot of over 10 000 pieces shall be selected for physical tests.

8.4 *Sampling for Chemical Analysis* — Atleast one sample for chemical analysis shall be taken from each lot. A sample shall consist of chips obtained by milling, drilling or crushing from atleast two pieces with clean, dry tools without lubrication. In order to obtain oil free chips the parts selected for test should be extracted by the process described in **4.3** of IS : 5642 - 1970 'Method for determination of interlocking porosity of sintered powder metal structural parts and oil-impregnated bearings'.

9. Inspection, Certificate of Test and Examination — When desired by the purchaser, the manufacturer shall supply a certificate of test and examination showing that the material conforms to this specification.

10. Marking — Shall be marked with the identification number and the manufacturer's initials or trade-mark, and any other mark as mutually agreed to between the purchaser and the manufacturer.

10.1 *Certification Marking* — Details available with the Bureau of Indian Standards.

TABLE 6 PHYSICAL PROPERTIES OF POROUS METAL POWDER OIL-IMPREGNATED BEARINGS

(*Clauses* 7.1, 7.2 *and* 7.3)

Grade	Class	Sub-class	Density g/cm^3	K-factor (*Min*) *MPa	Minimum Inter-connected Porosity %
1	A		5·8-6·2 (*L*)	100	25
			6·2-6·6 (*M*)	140	18
			6·6-7·0 (*H*)	180	12
	B	B1	5·7-6·1 (*L*)	100	25
			6·1-6·5 (*M*)	140	18
			6·5-6·9 (*H*)	180	12
		B2	5·6-6·0 (*L*)	100	25
			6·0-6·4 (*M*)	140	18
			6·4-6·8 (*H*)	180	12
		B3	5·5-5·9 (*L*)	100	25
			5·9-6·3 (*M*)	140	18
			6·3-6·7 (*H*)	180	12
2	A		5·4-5·8 (*L*)	150	22
			5·8-6·2 (*M*)	170	18
			6·2-6·6 (*H*)	250	12
	B	B1	5·4-5·8 (*L*)	180	22
			5·8-6·2 (*M*)	210	18
			6·2-6·6 (*H*)	250	12
		B2	5·4-5·8 (*L*)	250	22
			5·8-6·2 (*M*)	275	18
			6·2-6·6 (*H*)	310	12
		B3	5·4-5·8 (*L*)	270	22
			5·8-6·2 (*M*)	300	18
			6·2-6·6 (*H*)	340	12

Note — (*L*) = Low density
(*M*) = Medium density
(*H*) = High density

*1MPa = 0·102 kg/mm^2.

EXPLANATORY NOTE

This standard was first published by Rolling Bearings Sectional Committee, EDC 39 in 1967. Subsequent after the formation of Plain Bearings Sectional Committee, EDC 80, the subject was transferred to EDC 80. While reviewing the standard the concerned committee felt to revise the specification in line with current international practices.

In this revision, the major changes are as follows:

i) Title has been modified as 'Specification for porous metal powder oil-impregnated bearings';

ii) Changes in chemical composition of the material have been incorporated, for example, Grade 1 materials have been reclassified to read with progressively decreasing copper contents (and hence increasing iron contents). In view of this, the original Grade B1 is now B3 and vice-versa. This procedure is also in line with other major international standards;

iii) Table 3 has been modified in accordance with ISO 2795-1979 'Plain bearings made from sintered material — Dimensions and tolerances';

iv) Dimensions and tolerances have undergone revision;

v) Sampling plan for dimensions, physical tests and chemical analysis has been incorporated;

vi) Substantial revision has been made both in density classification and other bearing properties;

vii) Appendix B has been deleted as the information is now covered in Table 5;

viii) Appendix C has been completely deleted as the same is now covered under IS : 4841 (Part I)-1968 'Method for determination of density of sintered metallic materials', and IS : 5642-1970 'Method for determination of interlocking porosity of sintered powder metal structural parts and oil-impregnated bearings'.

The use of porous metal powder oil-impregnated bearing is increasing very fast in important industries, such as automobiles, textiles, machine tools, etc. For the information of users, general description about porous metal oil-impregnated bearings has been included in Appendix A.

APPENDIX A

(*Explanatory Note*)

GENERAL DESCRIPTION OF POROUS METAL POWDER OIL-IMPREGNATED BEARINGS

A-1. General — Porous metal powder oil-impregnated bearings are made by compressing metal powders in suitable moulds and then by sintering. They remain porous and can absorb up to 30 percent by volume of lubrication oil. This is the main distinguishing feature from other types of bearings which are non-porous and hence have no capacity for oil absorption. In use, this oil lubricates the journal running in the bearing and the amount contained in the body of the bearing serves as a reservoir, thus enabling the bearing to run under the recommended conditions of loading, speeds and temperature for long periods without attention. If, however, operating conditions make it necessary, provision can be made for extra oil to be added from time to time by such means as oil-soaked felts or wick feed lubricators in order to fill up the reservoir, without dismantling the bearings.

A-2. Oil — It is found that circulating type oils containing rust and oxidation inhibitors are the most desirable type of oils to be used. These oils normally have a viscosity range of 45-60 centistokes at 60°C with a high viscosity index.

A-3. Load — The biggest use of these bearings is for light load conditions, but the load can be increased to substantial values if the speed of running is decreased and particularly if the loading is intermittent, or the bearing has a relative density in excess of 80 percent. Table 7 gives guidance on loading in relationship with speed. If in doubt, the user should consult the manufacturer of these bearings.

A-4. Housing — It is assumed for the purpose of this standard, that the bearing housing is rigid. It is also pertinent to point out that housing material has considerable effect on the interference fit obtained after assembly and in extreme cases where an insufficiently thick housing of a soft material like aluminium is used, the housing itself may get distorted during installation of these bearings. It is, therefore, recommended that in such cases the manufacturers of these bearings may be consulted. It should be noted that there is a limit to the working temperature at which these bearings should be used. Normally, they may be used up to an ambient temperature of 80°C, beyond this point the manufacturers should be consulted.

A-5. Assembly — Fig. 4 to 6 illustrated typical arrangements of a plain, flanged and self-aligning bearing. The plain and flanged bearings shall be pressed into the housing using a hardened shouldered fitting pin and an arbor press or similar tool. Owing to the porous nature of the material, the required interference fit is higher than would be used with solid metal bearings. The contraction of the bearing bore, which occurs during assembly is controlled within fine limits by the use of a hardened fitting pin of the correct diameter. Experience has shown that the fitting pin should lie within the tolerance zone of m5. A lead-in is provided at the entry of the housing to prevent damage to the bearing.

A-6. Fits — It is recommended that the clearance fits shall either be H7 — f7 or H8 — f8 depending on the application in accordance with IS : 2709-1964 'Guide for the selection of fits'.

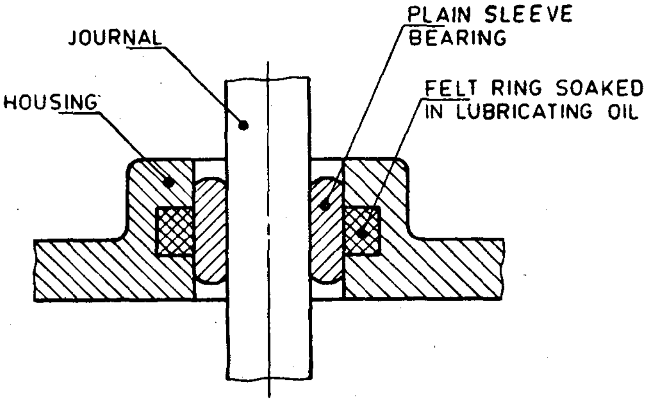

FIG. 4 ASSEMBLY OF PLAIN SLEEVE BEARING

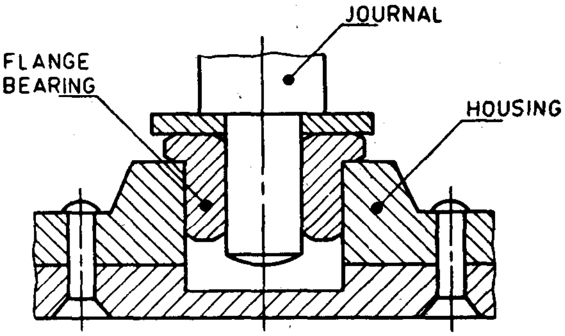

FIG. 5 ASSEMBLY OF FLANGED BEARING

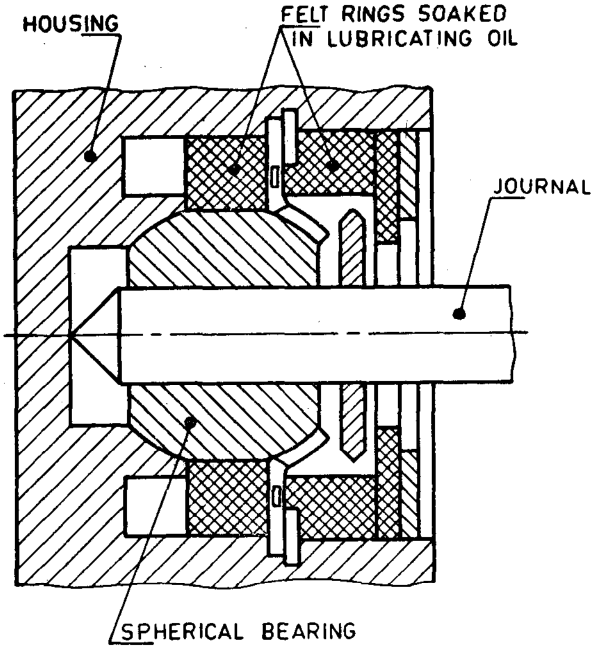

FIG. 6 ASSEMBLY OF SELF-ALIGNING BEARING

A-7. Storage — The bearings shall be stored in a closed non-absorbent container and kept at normal room temperature to avoid contamination and loss of oil. It is essential to dip the bearings in the grade of warm oil specified by the manufacturer before they are fitted into the housing, particularly if they have been stored for a considerable period of time.

TABLE 7 PERMISSIBLE LOADS FOR VARIOUS SHAFT VELOCITIES FOR THE LOWEST DENSITY RANGE OF POROUS METAL BEARINGS

(*Clause* A-3)

Shaft Velocity (m/s)	Maximum Pressure on Projected Bearing Area (MPa)	
	Grade 1	Grade 2
Static	35·0	100·0
Slow and intermittent	21·0	49·0
0·125 to 0·25	14·0	21·6
0·25 to 0·50	3·5	4·9
0·50 to 0·75	2·5	2·9
0·75 to 1·00	1·75	2·2

Note 1 — For shaft velocities over 1·00 m/s, the permissible loads may be calculated as follows:

$$P = \frac{1 \cdot 77}{V}$$

where

P = safe load in MPa of projected area, and
V = shaft velocity in m/s.

Note 2 — It is emphasized that this information is intended only as a general guide and under certain conditions, such as additional lubrication, hardened and ground shafts, and loads of short duration, the permissible loads can be increased.

On the other hand, it is necessary to reduce the permissible loads under conditions such as continuous stop start operations, reciprocating and oscillatory motion, high speeds, shock loading, extremes of high and low temperature, poor shaft finish or oil breakdown.

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TO
IS 3980 : 1982 SPECIFICATION FOR POROUS METAL POWDER OIL-IMPREGNATED BEARINGS

(First Revision)

(*Page* 5, *clause* **8.3**) — Substitute the following for the existing clause:

'**8.3** *Sampling for Physical Tests* — Unless otherwise agreed between the manufacturer and the purchaser five bearings from each lot of 10 000 bearings shall be selected at random for physical tests. The lot shall be accepted for physical requirements if all the specimens pass in physical tests, otherwise the lot shall be rejected.'

(LMD 11)

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